

REMARKS

Claims 1-15 were previously pending in the application.
Claims 1-15 are cancelled and replaced with new claims 16-19.

Claims 1-15 are rejected as unpatentable over CHEN et al. 6,420,258 in view of HASEGAWA et al. 5,793,112 and further in view of DIXIT et al. 6,566,258.

Reconsideration and withdrawal of the rejection are respectfully requested because the references do not teach or suggest a first interconnect through a first insulating film and directly contacting a substrate, the first interconnect comprising a trench having a metal barrier layer on walls and a bottom of the trench and a copper layer within the trench, a first diffusion barrier film directly on the first insulating film, a second diffusion barrier film directly on the first diffusion barrier film, a second insulating film directly on the second diffusion barrier film and a second interconnect through the first and second diffusion barrier films and the second insulating film, the second interconnect comprising a trench having a metal barrier layer on walls and a bottom of the trench and a copper layer within the trench as recited in claim 16 of the present application.

By way of example, Figure 2K of the present application discloses a first interconnect 10, 12 through the first insulating film 6 and directly contacting a substrate 4. The

first interconnect 10, 12 has a trench 10 having a metal barrier layer on walls and a bottom of the trench and a copper layer 12 within the trench 10. A first diffusion barrier film 16 is directly on the first insulating film 6. A second diffusion barrier film 18 is directly on the first diffusion barrier film 16. A second insulating film 20 is directly on the second diffusion barrier film 18. A second interconnect 11, 32 is through the first and second diffusion barrier films 16, 18 and the second insulating film 20. The second interconnect 11, 32 comprises a trench 11 having a metal barrier layer on walls and a bottom of the trench and a copper layer 32 within the trench 10.

CHEN et al. teach a single trench 46 with a copper interconnect 13 therein. As noted in the Official Action, CHEN et al. fail to disclose first and second diffusion preventive insulating films and the upper metal interconnection layer.

In an attempt to overcome these shortcomings, CHEN et al. is combined with HASEGAWA et al. and DIXIT et al. HASEGAWA et al. disclose a plurality of conductive metal portions 4, 9, 14. However, as seen in Figure 1 of HASEGAWA et al., for example, HASEGAWA et al. teach a single diffusion barrier layer 3, not first and second diffusion barrier layers.

DIXIT et al. teach plural diffusion barrier layers. However, as seen in Figure 4 of DIXIT et al., in conjunction with column 4, lines 31-42, for example, when making the second

interconnect 40, only lower stop layer 30 is removed but no substantial thickness of the thicker embedded stop layer 50 is removed. Accordingly, the second interconnect 40 is only through insulating layer 32 and second diffusion barrier film 30. DIXIT et al. do not teach or suggest that the second interconnect is through the first and second diffusion barrier films and the second insulating film as recited in claim 16 of the present application.

In addition, claim 16 of the present application recites that the second interconnect comprises a trench having a metal barrier layer on walls and a bottom of the trench and a copper layer within the trench.

Column 4, lines 26-30 of DIXIT et al. teach eliminating the barrier layer from the via bottom. Accordingly, layer 56 on the side walls of Figure 4 of DIXIT et al. is removed from the bottom of the via before the via is filled with copper interconnect 40. Therefore, DIXIT et al. teach away from a second interconnect comprising a trench having a metal barrier layer on walls and a bottom of the trench and a copper layer within the trench as recited in claim 16 of the present application.

The combination of references cited in the Official Action does not teach a second interconnect through first and second diffusion barrier films and a second insulating film and

thus this feature would not be obvious to one having ordinary skill in the art.

In addition, the closest reference to DIXIT et al. teaches away from a second interconnect comprising a trench having a metal barrier layer on walls and a bottom of the trench and a copper layer within the trench as recited in claim 16 of the present application. Accordingly, the proposed combination of references would not render obvious claim 16 of the present application.

Further, the multilayer structure set forth in claim 16 of the present invention uses a diffusion barrier film to prevent the surface of the copper interconnect from becoming rough, such that there is a smooth surface between interconnect layers to improve the connection therebetween.

The interlayer insulator disclosed by DIXIT et al. is an etch-stop layer. This layer allows the lower surface of the upper metal layer and the upper surface of the lower metal layer to be substantially even as seen in Figure 4 of DIXIT et al. However, this multilayer structure is different than the multilayer structure as seen in Figure 2K of the present application. Accordingly, combining DIXIT et al. with CHEN et al. and HASEGAWA et al. would result in a structure similar to Figure 4 of DIXIT et al. Absent impermissible hindsight reasoning, the structure as seen in Figure 2K of the present

application and as recited in claim 16 would not be obtained by the proposed combination of references.

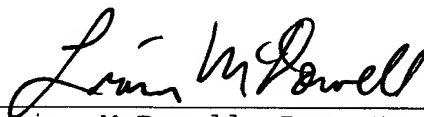
Claims 17-19 depend from claim 16 and further define the invention and are also believed patentable over the cited prior art. Accordingly, each of the new claims are believed to avoid the rejection under §103 and are believed allowable over the art of record.

In view of the present amendment and the foregoing remarks, it is believed that the present application has been placed in condition for allowance. Reconsideration and allowance are respectfully requested.

The Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 25-0120 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17.

Respectfully submitted,

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